ONTARIO

Ministry of the ENVIRONMENT

BACTERIOLOGICAL STATUS of OXTONGUE LAKE

Haliburton County

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by

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OXTONGUE LAKE

Introduction

The "Self-Help" program, set up by the Ontario Water Resources Commission in conjunction with interested cottagers' associations in 1971 and continued by the Ministry of the Environment in 1972, was initiated to assist cottagers' assocications in determining the general bacteriological water quality of their lake. Initial investigations of a lake by the "Self-Help" program will be useful in determining which lakes require intensive surveys in later years and will give an indication of possible pollution sources which require immediate investigation.

The success of this program depended on the enthusiastic support of the cottagers association and individual cottage owners on the lake and especially Mr. Jim Elliott,who gave their time and effort to take the samples and deliver them within twenty-four hours to the Toronto Laboratory and the Ministry of the Environment personnel who supplied the sterile 6 ounce bottles, and did the analyses on the samples.

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Laboratory Methods

Bacteriological samples were taken at twenty-one selected sampling stations on July 16, and August 13 and twenty-two stations on September 6, 1972 and transported on ice, to the Toronto Laboratory. These samples were analyzed within twenty-four hours for total coliform (TC), fecal coliform (FC) and fecal streptococci (FS) using the membrane filtration (MF) technique (Standard Methods, 13th edition) the only exception being: m-Endo Agar Les (Difco) was used for total coliform and MacConkey membrane broth (Oxoid) was used for fecal coliform determinations.

The total coliforms, fecal coliforms and fecal streptococci were used as "indicators" of fecal pollution. These "indicators" are the normal flora of the large intestine, and are present in large numbers in the feces of man and animals. When water is polluted with fecal material, there is a potential danger that pathogens or disease causing microorganisms may also be present.

The coliform group is defined, according to Standard Methods, 13th Edition, as "all of the aerobic and facultative anaerobic, gram-negative, non-sporeforming rod-shaped bacteria which ferment lactose with gas formation within

48 hours at 35 °C" and/or "all organisms which produce a colony with a golden green metallic sheen within 24 hours of incubation" using the MF technique. This definition includes, in addition to the intestinal forms of the _Escherichia coli_ group, closely related bacteria of the genera _Citrobacter_ and _Enterobacter_. The _Enterobacter_ - _Citrobacter_ groups are common in soil, but are also recovered in feces in small numbers and their presence in water may indicate soil runoff or, more important, less recent fecal pollution since these organisms tend to survive longer in water than do members of the _Escherichia_ group, and even to multiply when suitable environmental conditions exist. A more specific test for coliforms of intestinal origin is the fecal coliform test, with incubation of the organisms at 44.5 °C. Though by no means completely selective for _Escherichia coli_, this test has proved useful as an indicator of recent fecal pollution.

Fecal streptococci (or enterococci) are also valuable indicators of recent fecal pollution. These organisms are large, ovoid gram-positive bacteria, occurring in chains. They are normal inhabitants of the large intestine of man and animals, and they generally do not multiply outside

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the body. In waters polluted with fecal material, fecal streptococci are usually found along with coliform bacteria, but in smaller numbers, although in some waters they may be found alone. Their presence, along with coliforms, indicates that at least a portion of the coliforms in the sample is of fecal origin.

The bacteriological data collected in these surveys was summarized and compared to the M.O.E. Guidelines and Criteria for Total Body Contact Recreational Use (Ministry of the Environment, 1972). Generally, this criteria states: Recreational waters can be considered impaired when the total coliform, fecal coliform and/or fecal streptococcus exceeds 1000, 100 and/or 20 per 100 ml respectively, in a series of at least 10 samples per month.

Discussion:

Generally the bacteriological water quality of Oxtongue Lake during the three sampling days was very good and well within the Ministry of the Environment's Criteria for recreational use. However, there were indications of bacterial contamination gaining access to the lake especially along the Oxtongue River (Figure 1). Bacterial inputs were detected by: Stations 1 and 1a, situated in the Oxtongue River; Station 2 in the river delta and Station 3 which is situated within the influence of the Oxtongue River (Table 1). Data collected and tabulated by Mr. Ellliott in 1971 also indicated a high incidence of fecal coliform organisms and further substantiates the implication that bacterial contamination is gaining access to the Oxtongue River.

Station 12, centrally located in the south bay indicated a bacterial input, as did the water sample taken in 1971, the same was true of Station 14 located near the outflow and Station 18 located near the west shore. Both latter stations indicated bacterial pollution sources in 1971 and 1972. Although the bacterial numbers detected at these stations were not very high, they may have been quite distant from the actual pollution source and the bacterial concentrations would have been diluted.

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The July 16 survey following the heavy rainfall did not seem to indicate appreciably higher bacterial levels which implies that the "rainfall effect" (see Appendix) was minimal and that there was very little fecal pollution being carried into the lake by the runoff. However, the FC to FS ratios on August 13 for Stations 1 and 3 was approximately 1.5 and the ratio for Station 18 was 20. Past data has shown that FC to FS ratios this high are normally associated with fecal pollution of human origin.

Although Oxtongue Lake water was well within the recreational use criteria, no surface water can be considered safe for human consumption without prior treatment including disinfection.

OXTONGUE LAKE

FIG 1

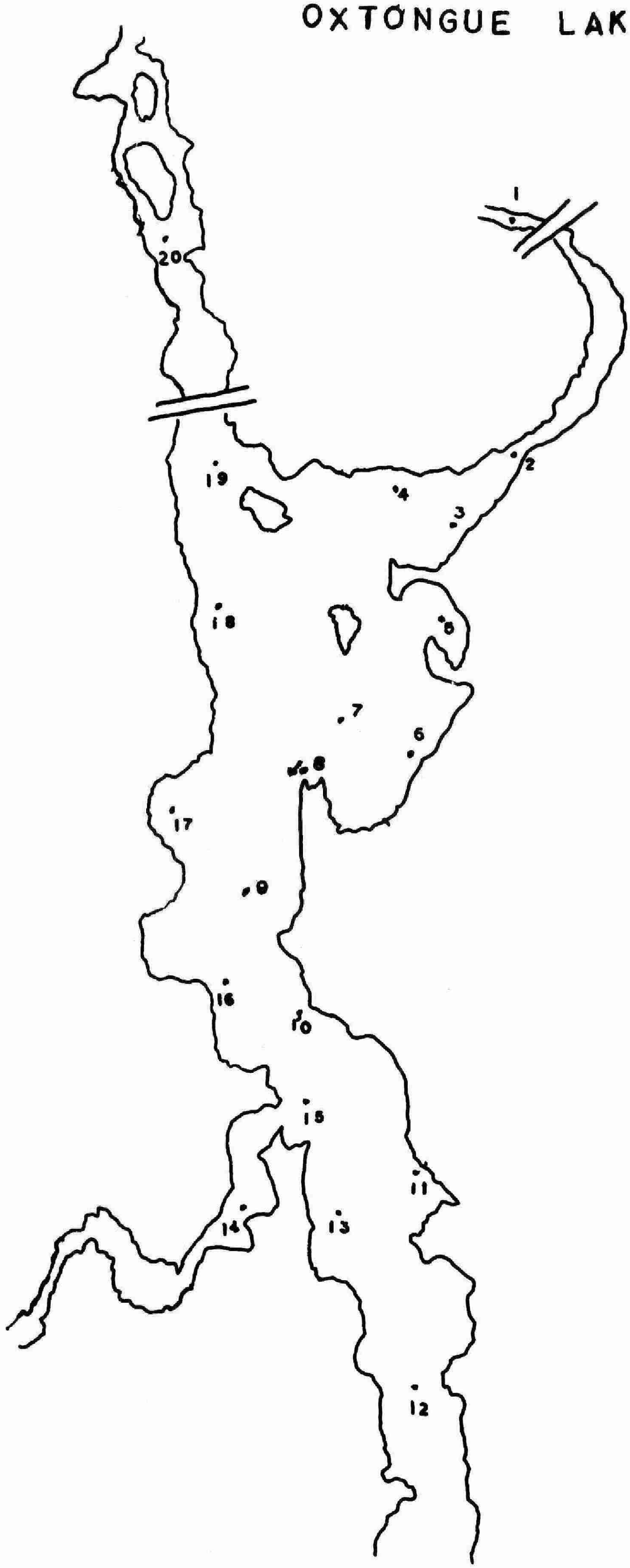

TABLE I

OXTONGUE LAKE DATA 1972

Stn. #	TC / 100 ml			FC / 100 ml			FS / 100 ml		
	July	August	September	July	August	September	July	August	September
1	52	32	128	12	12	1	32	8	4
1a	52	32	156	24	12	4	4	20	4
2	36	32	204	32	1	4	56	12	1
3	24	88	284	1	12	1	1	8	1
4	28	88	32	4	1	1	1	8	1
5	20	36	92	1	1	1	1	1	1
6	60	44	148	1	1	1	1	1	1
7	1	40	140	1	1	1	1	1	1
8	44	36	152	1	1	1	1	1	1
9	16	12	80	1	1	1	1	4	4
10	40	12	100	1	1	1	4	1	1
11	20	24	104	1	1	1	4	1	1
12	60	60	156	8	1	1	8	1	1
13	36	72	92	4	1	1	1	1	1
14	68	60	108	1	4	1	4	4	1
15	32	48	52	4	1	1	1	1	1
16	48	60	64	1	1	1	1	1	1
17	8	56	132	4	1	1	1	1	1
18	140	128	84	8	20	1	4	1	1
19	60	140	64	1	1	1	8	1	1
20	16	124	108	1	1	1	1	1	1
20a			132			1			1

APPENDIX

MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microoganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria do not change the appearance of the water but pose an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections like: typhoid fever, polio or hepatitis, although this is a distinct possibility, but he may catch lesser infections like: gastroenteritis (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated

with several water born viruses. These viral infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and the water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic matter in the lake will be used as food by these organisms and will give rise, in turn, to subsequent increases in their numbers. Natural organic matter (like plant material) as well as sewage, kitchen wastes, oil and gasoline are readily attacked by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses a correspondingly large amount of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling.

Boil the water for a minumum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5 1/4% Available Chlorine.

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination.

For continuous water disinfection, a small domestic hypochlorinator (sometimes coupled with activated charcoal filters) can be obtained from a local plumber or water euqipment supplier.

(d) Well Water Treatment.

Well Water can be disinfected using a household

bleach (assuming strength at 5% available chlorine) if the depth of water and diameter of the well are known.

Diameter of Well Casing In Inches	CHLORINE BLEACH per 10 ft. depth of water: One to Ten Coliforms	More than Ten Coliforms
4	.5 oz.	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will nor supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated

with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.